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Abstract: Objective: Late outcome after mitral valve repair was examined to define preoperative predictors of recurrent atrial fibrillation late after successful mitral valve reconstruction. Methods: One hundred and eighty-nine patients, 112 with preoperative sinus rhythm and 72 with preoperative chronic or intermittent atrial fibrillation, were followed for 12.2±10 years after valve repair. Clinic, hemodynamic end echocardiographic data were entered into Cox-regression and Kaplan-Meyer analysis to assess predictors for recurrent atrial fibrillation late after successful mitral valve repair. Results: Univariate and multivariate predictors for recurrent atrial fibrillation late after successful mitral valve reconstruction were preoperative atrial fibrillation (P=0.0001), preoperative antiarrhythmic drug treatment (P=0.005), heart rate (P=0.01), left ventricular ejection fraction (P=0.01) and increased left ventricular posterior wall thickness (P=0.05). Patients>57.5 years with a mean pulmonary artery pressure 23mm Hg and a history of preoperative antiarrhythmic drug treatment had an odds ratio of 53.33 (95% confidence limits 6.12-464.54) for atrial fibrillation late after successful mitral valve repair. Conclusion: Older patients with a history of atrial fibrillation, antiarrhythmic treatment or an elevated pulmonary artery pressure may present atrial fibrillation late after successful mitral valve repair. They could be considered for combined mitral valve reconstruction and surgery for atrial fibrillation even though sinus rhythm is present preoperatively

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Preoperative predictors of recurrent atrial fibrillation late after successful mitral valve reconstruction[1]

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Abstract

Objective: Late outcome after mitral valve repair was examined to define preoperative predictors of recurrent atrial fibrillation late after successful mitral valve reconstruction. **Methods**: One hundred and eighty-nine patients, 112 with preoperative sinus rhythm and 72 with preoperative chronic or intermittent atrial fibrillation, were followed for 12.2 ± 10 years after valve repair. Clinic, hemodynamic end echocardiographic data were entered into Cox-regression and Kaplan–Meyer analysis to assess predictors for recurrent atrial fibrillation late after successful mitral valve repair. **Results**: Univariate and multivariate predictors for recurrent atrial fibrillation late after successful mitral valve reconstruction were preoperative atrial fibrillation ($P = 0.0001$), preoperative antiarrhythmic drug treatment ($P = 0.005$), heart rate ($P = 0.01$), left ventricular ejection fraction ($P = 0.01$) and increased left ventricular posterior wall thickness ($P = 0.05$). Patients > 57.5 years with a mean pulmonary artery pressure ≥23mm Hg and a history of preoperative antiarrhythmic drug treatment had an odds ratio of 53.33 (95% confidence limits 6.12–464.54) for atrial fibrillation late after successful mitral valve repair. **Conclusion**: Older patients with a history of atrial fibrillation, antiarrhythmic treatment or an elevated pulmonary artery pressure may present atrial fibrillation late after successful mitral valve repair. They could be considered for combined mitral valve reconstruction and surgery for atrial fibrillation even though sinus rhythm is present preoperatively.

Keywords: Atrial fibrillation; Mitral valve; Late results

1. Introduction

Atrial fibrillation is the most common heart rhythm disturbance and results in significant cardiovascular and cerebrovascular mortality and morbidity [1]. The prevalence of atrial fibrillation is variable ranging up to 75% in patients with severe mitral valve regurgitation [2]. Surgery for atrial fibrillation – such as the maze procedure – may be effective in restoring normal sinus rhythm in patients with chronic atrial fibrillation [3] and has been found to be an ideal complement to reconstructive mitral valve surgery since long lasting atrial fibrillation rarely converts to normal sinus rhythm after mitral valve surgery [4]. Although surgery for atrial fibrillation can be combined with mitral valve surgery without adding undue operative risks [5], there may be – e.g. in the setting of a maze procedure – a significant requirement for postoperative pacemaker implantation [3]. In addition, multiple incisions in the atrial wall may cause delayed improvement in exercise capacity [6] or a temporary loss of cardiac autonomic innervation [7]. Thus, the decision to combine reconstructive mitral valve surgery with surgery for atrial fibrillation should be based on the knowledge of the heart rhythm late after mitral valve repair to identify those patients who presumably will benefit from this more invasive approach.

Therefore, we undertook the present retrospective study to define preoperative predictors for recurrent chronic or intermittent atrial fibrillation late after successful mitral valve repair.

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2. Materials and methods

2.1. Patients

All medical and surgical data were recorded from patients who had primary, isolated mitral valve repair between 1976 and 1994 at the Division of Cardiovascular Surgery, University Hospital, Zurich. Follow-up information was obtained by direct contact with the patients and the primary care physician.

The study group consisted in 189 patients, 121 (64%) men and 68 (36%) women. The mean age at operation was 56 ± 14 years. Indication for the operation was pure mitral valve regurgitation in 156 patients (83%), mitral valve stenosis in 16 (8%) and combined mitral valve disease in 17 patients (9%). Preoperatively, sinus rhythm was found in 112 patients (59%), chronic atrial fibrillation in 49 (26%) and documented intermittent atrial fibrillation in 28 (15%). The mean preoperative duration of atrial fibrillation was 43 months (range, 1 months to 9.5 years). Digoxin, the most frequently used preoperative antiarrhythmic drug, was prescribed in 108 patients (57%), whereas 99 (52%) had various other antiarrhythmic drugs prior to mitral valve repair.

The associated cardiovascular co-morbidity was low: hypertension was present in 38 patients (20%), coronary artery disease in 15 (8%) and insulin-dependent diabetes mellitus in seven (4%).

Preoperative echocardiographic and hemodynamic data are summarised in Table 1. End systolic and end diastolic left ventricular dimensions, measured by echocardiography, as well as left ventricular posterior wall thickness have been obtained in 80% of patients only.

Patients with residual or recurrent mitral valve regurgitation ≥ grade 2, reoperative cardiac-thoracic surgery during follow-up and those who were in the New York Heart Association class III and IV, were excluded from this study. Only patients with complete data and a documented electrocardiographic study at the end of follow-up were analysed. Fifteen percent of patients operated during the study period were lost to follow-up. The mean follow-up time of the study was 12.2 ± 10 years, with a median follow-up of 11 years.

Table 1
Preoperative hemodynamic and echocardiographic data in patients undergoing isolated reconstructive mitral valve surgery

Preoperative heart rate (beats/min)	78.5 ± 16.5
Left atrial dimension (cm)	5.2 ± 1.1 (range 2.6–9.2)
LVEDD (cm)	6.4 ± 1.1
LVESD (cm)	4.0 ± 0.8
Ventricular septal wall thickness (mm)	10.2 ± 2.2
Left ventricular posterior wall thickness (mm)	9.3 ± 2.5
LFEF (%)	63.5 ± 11
LVEDP (mmHg)	13.7 ± 7.3
Wedge-pressure (mmHg)	16.1 ± 8.0
Cardiac index (l/min)	2.7 ± 0.7
PAPS (mmHg)	39 ± 18.7
PAPD (mmHg)	15.9 ± 9.3
Mean PAP (mmHg)	25.8 ± 13.6

LVEDD, left ventricular end-diastolic dimension; LVESD, left ventricular end-systolic dimensions; LFEF, left ventricular ejection fraction; LVEDP, left ventricular end-diastolic pressure; PAPS, systolic pulmonary artery pressure; PAPD, diastolic pulmonary artery pressure; PAP, pulmonary artery pressure.

2.2. Operative technique

A median sternotomy was performed in all patients. Standard cardiopulmonary bypass was used either with a single two-stage cannula in the right atrium or with bicaval cannulation. Ventricular fibrillation was induced and the left atrium was then opened dorsally and perpendicular to the Waterstone line to assess mitral valve pathology. If technically feasible, the mitral valve was repaired during induced ventricular fibrillation. Otherwise, the aorta was cross-clamped and the heart arrested using antegrade, and in recent years combined antegrade-retrograde cardioplegia. The mitral valve was reconstructed using standard Carpentier's technique [8,9]. The left atrium was closed with a non-absorbable running polypropylene suture. Surgery in the left atrial appendage, usually a silk ligature around its broad base, has been performed inconsistently and, therefore, has not been evaluated as a preoperative predictor for late atrial fibrillation. De-airing, weaning from cardiopulmonary, decannulation and chest closure were conducted in the usual manner.

2.3. Statistical analysis

Descriptive statistics are expressed as means ±S.D. Stepwise logistic regression was used to analyse preoperative predictors for atrial fibrillation at the end of follow-up. The Cox regression determined hazard ratios for episodes of atrial fibrillation during the follow-up period, regardless of the heart rhythm found at the end of the follow-up period. Preoperative predictors were analysed for all patients and for those with preoperative atrial fibrillation. A linear regression model was used to define preoperative cut-off points for recurrence of postoperative atrial fibrillation. Values of $P < 0.05$ were considered to be of statistical significance. All calculation were performed using a commercially available statistical package (SPSS for Windows 6.0).

3. Results

3.1. Preoperative predictors for late atrial fibrillation: all patients (Tables 2 and 3)

The presence of preoperative chronic or intermittent atrial fibrillation ($P = 0.0001$), older age at operation ($P = 0.005$) and increased heart rate ($P = 0.05$) were the

Table 2
Logistic regression: univariate analysis: all patients

	Odds ratio	95% CL	*P*-value
Preop. chronic AF	20.9	7.7–56	0.0001
Preop. intermittent AF	5.08	2.0–12.5	0.0005
Age at operation/year	1.05	1.02–1.07	0.001
Preop. antiarr. therapy	3.14	1.6–5.9	0.001
Preop. digoxin	2.98	1.5–5.7	0.001
LVEF/%	0.96	0.93–0.99	0.005
Duration AF/months	1.04	1.0–1.07	0.005
Heart rate/min	1.03	1.0–1.05	0.01
LVESD/cm	1.78	1.18–2.69	0.01
Left atrial diameter/cm	1.47	1.07–2.02	0.05

CL, confidence limits; preop, preoperative; AF,:atrial fibrillation; antiarr., antiarrhythmic; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter.

strongest predictor for atrial fibrillation late after mitral valve surgery, in univariate as well as in multivariate analysis.

To give an example, a 60-year-old patient has a 1.05^{10} higher risk for late atrial fibrillation than a 50-year-old, whereas a 75-year-old patient would have a 1.05^{25} higher risk to be in late atrial fibrillation compared to the 50-year-old. Accordingly, a patient with a 48-month history of atrial fibrillation prior to mitral valve surgery has a 1.04^{36}higher risk to be in atrial fibrillation late after mitral valve repair than a patient with a 12-month history of preoperative atrial fibrillation.

A history of preoperative digoxin medication had nearly a threefold risk for late atrial fibrillation although this was not an independent predictor ($P = 0.001$). Surprisingly, an increased left atrial diameter, longer preoperative duration of atrial fibrillation and a reduced left ventricular ejection fraction were not found to be independent predictors.

3.2. Preoperative predictors for late atrial fibrillation: patients with atrial fibrillation prior to mitral valve repair (Tables 4 and 5)

For patients with preoperative atrial fibrillation, increased mean pulmonary artery pressure ($P = 0.05$), older age at operation ($P = 0.05$) and a history of chronic versus intermittent atrial fibrillation prior to mitral valve repair ($P = 0.05$) were the most important predictors for atrial fibrillation late after successful mitral valve reconstruction. A history of preoperative antiarrhythmic drug treatment had a fourfold risk to be in late atrial fibrillation although it was not an independent predictor.

Table 3
Logistic regression: multivariate analysis: all patients

	Odds ratio	95% CL	*P*-value
Preop. chronic AF	17.7	5.5–57.5	0.0001
Preop. intermittent AF	6.29	2.25–17.6	0.0005
Age/year	1.05	1.01–1.09	0.005
Heart rate/min	1.03	1.0–1.06	0.05

CL, confidence limits; preop., preoperative; AF, atrial fibrillation.

Table 4
Logistic regression: univariate analysis: patients with atrial fibrillation prior to mitral valve surgery

	Odds ratio	95% CL	*P*-value
Age/year	1.09	1.04–1.14	0.001
Preop. antiarrhythmic drugs	4.40	1.38–14.03	0.01
PAP diastolic/mmHg	1.23	1.05–1.44	0.01
LV posterior wall/mm	1.96	1.2–3.21	0.01
Heart rate/min	1.04	1.0–1.08	0.05
PAP systolic/mmHg	1.10	1.01–1.2	0.05
PAP mean/mmHg	1.14	1.02–1.28	0.05
Intermittent. vs. chronic AF	0.24	0.08–0.77	0.05

CL, confidence limits; preop., preoperative; PAP, pulmonary artery pressure; LV, left ventricular.

3.3. Preoperative predictors for episodes of atrial fibrillation during the follow-up period: all patients (Tables 6 and 7)

The lack of preoperative sinus rhythm ($P = 0.0001$), increased left atrial diameter ($P = 0.005$), decreased left ventricular ejection fraction ($P = 0.01$) and older age at operation ($P = 0.05$) were independent predictors for recurrent episodes of atrial fibrillation during the follow-up period. Longer duration of atrial fibrillation prior to surgery and increased left ventricular end-systolic diameter were found to be significant predictors only in univariate analysis.

3.4. Preoperative predictors for episodes of atrial fibrillation during the follow-up period: patients with atrial fibrillation prior to mitral valve surgery (Tables 8 and 9)

Increased left atrial diameter ($P = 0.05$) and increased posterior left ventricular wall thickness ($P = 0.05$) predicted independently episodes of atrial fibrillation late after mitral valve repair. A history of preoperative antiarrhythmic drug treatment, increased cardiopulmonary bypass time or older age at operation were univariate predictors only.

3.5. Atrial fibrillation-index

For patients who were in chronic or intermittent atrial

Table 5
Log. regression: multivariate analysis: patients with atrial fibrillation prior to mitral valve surgery

	Odds ratio	95% CL	*P*-value
PAP mean/mmHg	1.21	1.04–1.4	0.05
Age/year	1.06	1.0–1.13	0.05
Intermittent vs. chronic AF	8.35	15–46.7	0.05

CL, confidence limits; PAP, pulmonary artery pressure.

Table 6
Cox regression: univariate analysis: all patients

	Hazard-ratio	95% CL	*P*-value
Lack of preop. SR	5.98	3.7–9.64	0.0001
Duration AF/months	1.01	1.00–1.01	0.0001
Left atrial diameter/cm	1.52	1.2–1.92	0.0005
Digoxin	2.25	1.44–3.51	0.0005
LVESD/cm	1.56	1.2–2.04	0.005
LVEF/%	0.97	0.96–0.99	0.005
Age/year	1.03	1.02–1.05	0.005

CL, confidence limits; preop., preoperative; LVESD, left ventricular end-systolic diameter; LVEF, left ventricular ejection fraction; AF, atrial fibrillation.

fibrillation prior to mitral valve repair, combined cut-off points, called the 'atrial fibrillation index', were found, predicting the presence of atrial fibrillation late after successful mitral valve reconstruction: age at operation $>$ 57.5 years (1 point), mean pulmonary artery pressure ≥15 mmHg (1 point) or mean pulmonary artery pressure ≥23 mmHg (2 points), and a history of antiarrhythmic drug treatment (1 point) were found to be significant predictors for late atrial fibrillation. The presence of >3 points predicted late atrial fibrillation with a specificity of 92.3% and a sensitivity of 77.6%. Although its negative predictive value was only 52.2%, >3 points had a positive predictive value of 97.4% and an odds ratio of 41.45 (95% confidence limits 4.84–355.00) and this was highly significant ($P < 0.0001$).

For patients $>$57.5 years having a mean pulmonary artery pressure ≥23 mmHg prior to mitral valve repair (that is >3 points from age and mean pulmonary artery pressure only), the sensitivity and specificity for the presence of late atrial fibrillation was 81.6%, respectively, 92.3% with a positive predictive value off 97.6% and a negative predictive value of 57.1%. In these patients, the atrial fibrillation index had an odds ratio of 53.33 (95% confidence limits 6.12–464.48 and this was highly significant ($P < 0.0001$).

3.6. Operative technique

Increased cardiopulmonary bypass time was an univariate predictor for episodes of atrial fibrillation ($P = 0.05$) late after successful mitral valve repair. A cut-off point was not found. Neither aortic cross clamp time, mitral valve pathology nor specified techniques of mitral valve repair were found to predict postoperative heart rhythm.

Table 7
Cox regression: multivariate analysis: all patients

	Hazard-ratio	95% CL	*P*-value
Lack of preoperative SR	4.72	2.8–7.95	0.0001
Left atrial diameter/cm	1.48	1.16–1.89	0.005
LVEF >60%	0.28	0.11–0.72	0.01
Age/year	1.02	1.00–1.04	0.05

CL, confidence limits; LFEV, left ventricular ejection fraction.

Table 8
Cox regression: univariate analysis: patients with atrial fibrillation prior to mitral valve surgery

	Hazard-ratio	95% CL	*P*-value
Preop. antiarr. drugs	1.91	1.04–3.48	0.05
Left atrial diameter/cm	1.34	1.03–1.76	0.05
LV posterior wall/mm	1.19	1.01–1.40	0.05
CPB time/min	1.01	1.00–1.02	0.05
Age/year	1.03	1.01–1.05	0.05

CL, confidence limits; preop., preoperative; antiarr., antiarrhythmic; LV, left ventricular.

4. Discussion

The strong cerebrovascular risk of chronic atrial fibrillation cannot be adequately eliminated by conventional treatment such as long-term oral anticoagulation, electrical- and/or drug-induced conversion, drug-induced ventricular rate-control or catheter ablation technique [10–12]. Despite the decline of the incidence of rheumatic heart disease, mitral stenosis and mitral insufficiency are commonly associated with atrial fibrillation and systemic embolism. Up to 80% of patients with chronic atrial fibrillation before surgery remained in atrial fibrillation even after an otherwise successful mitral valve repair [4]. Thus, in patients undergoing mitral valve reconstruction, simultaneous elimination of the arrhythmia is desirable to prevent antiarrhythmic treatment and long-term anticoagulation as well as continuing atrial enlargement as the consequence of chronic atrial fibrillation [13]. Therefore, surgery for atrial fibrillation has been successfully combined with mitral valve surgery by several groups [4,5,14]. Kosakai proposed that every patient with atrial fibrillation undergoing mitral valve surgery should be considered for the combined maze procedure [15].

However, performing combined surgery for atrial fibrillation, e.g. the maze operation, an average cross-clamping time of 48–70 min is required [3,14] as compared with the valvular procedures alone, implying an additional burden on the heart. In addition, delayed sinus node function recovery [16], dual-chamber pacemaker implantation in up to 40% of patients [3], attenuated sinoatrial node response to exercise [6] and temporary loss of cardiac autonomic innervation [7] are described after atrial surgery. Thus, the indication to combine surgery for atrial fibrillation with mitral

Table 9
Cox regression: multivariate analysis: patients with atrial fibrillation prior to mitral valve surgery

	Hazard-ratio	95% CL	*P*-value
LA diameter/cm	1.41	1.07–1.86	0.05
LV posterior wall/mm	1.21	1.03–1.42	0.05
CPB time/min	1.01	1.00–1.02	0.055

CL, confidence limits; LA, left atrial; LV, left ventricular; CPB, cardiopulmonary.

valve repair should be based on careful identification of patients who will likely benefit from a more extended surgical approach.

The aim of this study was to identify preoperative variables that would accurately predict the presence of atrial fibrillation late after successful mitral valve repair in patients with preoperative atrial fibrillation and in those who were in sinus rhythm prior to surgery. The presence of preoperative chronic or intermittent atrial fibrillation, increased heart rate, older age at operation and increased mean pulmonary artery pressure were the strongest predictors for atrial fibrillation late after mitral valve reconstruction. Longer duration of atrial fibrillation prior to surgery, increased left atrial diameter and reduced left ventricular function were not found to be independent predictors for late atrial fibrillation. This is surprising, as in Kosakai's study, a larger left atrial dimension and a longer time of preoperative atrial fibrillation failed to restore sinus rhythm after successful mitral valve repair combined with the maze procedure [15].

Although of low prevalence in this study, cardiovascular risk factors commonly associated with an increased incidence of atrial fibrillation, such as arterial hypertension or coronary artery disease were not found to be important variables in this study predicting late atrial fibrillation.

Predictors for episodes of atrial fibrillation during the follow-up period irrespective of the heart rhythm observed at the end of the follow-up were similar and were the same for all patients regardless whether they were in preoperative sinus rhythm or atrial fibrillation. Again, older age as well as intermittent atrial fibrillation have found to be independent risk factors for chronic or intermittent atrial fibrillation late after mitral valve repair. Thus, surgery for atrial fibrillation presumably should not be restricted to patients with chronic arrhythmias who are young and would be expected to have the long term risks of anticoagulation and antiarrhythmic drug treatment as suggested by Chua et al. [4].

Based on our data, we were able to create a simple atrial fibrillation index for age at operation, mean pulmonary artery pressure and a history of antiarrhythmic drug treatment allowing us to identify those patients with the highest probability to be in atrial fibrillation late after mitral valve repair. Interestingly, in this study, it was not possible to define a specific duration of atrial fibrillation prior to mitral valve surgery, e.g. like recent onset atrial fibrillation [15] or atrial fibrillation lasting for 1 year prior to mitral valve surgery [17], advocating combined surgery for atrial fibrillation.

There are several limitations of our study: first, it is a retrospective analysis, based on echocardiographic findings obtained 15–20 years ago; second, left ventricular dimensions, measured by echocardiography, were available in only 80% of patients; third, 15% of patients were lost to follow-up; fourth, improvements in operative technique during the study period, such as the introduction of blood or combined antegrade-retrograde cardioplegia may have had an impact on the presence of atrial fibrillation late after mitral valve surgery; fifth, results of the Cox regression are thought to be less reliable in that it is almost impossible to detect all episodes of atrial fibrillation during a long-term follow-up after mitral valve repair. Nevertheless, predictors found with Cox regression were similar to those obtained by linear regression. The risk of occurrence of atrial fibrillation over time after successful mitral valve reconstruction – a kind of an actuarial survival curve of the sinus rhythm after successful mitral valve repair – has not been addressed, because it was not possible to define precisely the exact onset of atrial fibrillation during the follow-up time.

In conclusion, the present study indicates that older patients with chronic or intermittent atrial fibrillation, a history of antiarrhythmic drug treatment and an elevated mean pulmonary artery pressure are at a substantial risk for recurrent atrial fibrillation late after successful mitral valve reconstruction. In these patients, mitral valve repair could be combined with surgery for atrial fibrillation even though sinus rhythm is present preoperatively. In addition, an increased preoperative heart rate, an enlarged left atrium, a decreased left ventricular function and an increased thickness of the posterior left ventricular wall function support the assumption to combine mitral valve repair with surgery for atrial fibrillation.

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Appendix A. Conference discussion

Dr J. Melo (*Carnaxide, Portugal*): I think this is a very important paper regarding all the problems related with atrial fibrillation and surgical procedures. Looking at your conclusions, you are advising prophylactic maze operation. I have difficulty understanding the recommendation for prophylactic maze operation on that setting of patients because the maze operation is a risky operation. So in your experience, what is the risk of the maze operation concomitant with mitral valve surgery in order that you are able to recommend the concomitant procedures?

Dr Vogt: We combined maze and mitral valve surgery in about 25 patients so far. We have seen an increased aortic cross clamp and cardiopulmonary bypass time. The mean increase in aortic cross clamp time was 48 min. After the combined maze operation, patients were 1 or 2 days longer on the intensive care station compared to isolated mitral valve repair. An increased incidence of pacemaker implantation, as reported by Cox, has not been observed in our patients. In our opinion, the maze operation can safely be combined with mitral valve repair.

Dr Melo: In every patient? Do you think there are limitations for those indications? I agree that there are strong indications to add the procedure, but I don't see reasons to accept these recommendations as a general rule. So what would be the limitation of this general recommendation?

Dr Vogt: The absence of these independent predictors late atrial fibrillation as presented. I think in patients with chronic atrial fibrillation for 1 year or some months only, or in those with intermittent atrial fibrillation or with a history of antiarrhythmic treatment, to combine maze and mitral valve repair is not prophylactic. Even though patients are in sinus rhythm prior to surgery, they suffered from atrial fibrillation which may return and persist postoperatively. As we have seen in our retrospective study, atrial fibrillation can occur again late after mitral valve repair. After successful mitral valve repair, the advantage to be free from anticoagulation will be denied by the onset of atrial fibrillation. I think in patients who present these strong predictors, who had a history of atrial fibrillation or a mean pulmonary artery pressure >25 mmHg the combined maze is not a prophylactic operation. It is a safe operation and we would recommend it.

Dr A. Moritz (*Frankfurt, Germany*): There are people now suggesting mini-maze procedures dealing only with the left atrium or encircling pulmonary veins. Do you, from your data, have any indications that atrial fibrillation in your patients originates from the left or the right atrium? If the pulmonary artery pressure is one predictive factor, also the right atrium? If the pulmonary artery pressure is one predictive factor, should be involved in the origin or etiology or the atrial fibrillation. Do you have any data on this?

Dr Vogt: We have performed operations using the mini-maze technique, but we were not happy with this technique because patients remained in chronic atrial fibrillation postoperatively. I know there are papers who tell us that if the pathology is in the left atrium, like in mitral valve regurgitation, one can do only a so called left-sided maze. As Cox mentioned most of the newer techniques trying to minimise the maze operation are not tested electrophysiologically. I think we should be careful to use simpler, alternative maze techniques. As I said, we were not pleased with the mini-maze.

Dr Moritz: Well, If you suggest to do a maze procedure prophylactically this would be maybe a trade-off of decreasing the operative risk. In other words, we have a few patients where we did a simple right maze for ASDs or tricuspid incompetence and that worked quite nice.

Dr Vogt: As I said, we don't find that it's just prophylactically. We feel it safe to combine the maze with other operations. We would continue recommend the advanced maze III.

Dr Melo: If you have a calcified left atrium, or if you have a 60-year-old patient with a general condition incompatible with a long bypass, atrium, or if you general condition would you still advise this combination or procedures?

Dr Vogt: No, I think if there are additional factors that would increase perioperative risk, if left ventricular function is worse, if there is a left atrium more than 7 cm in diameter, as described by Kosakai we would hesitate to perform an additional maze, that's true. But I think for each patient the decision to do a maze or not has to be individualized.